FINAL REPORT

DESIGN OF A RIDE COMFORT SYSTEM

ON A

CESSNA 172K AIRCRAFT

NASA CONTRACT NAS1-14013

NASA STATEMENT OF WORK 1-12-5563

EXHIBIT A

DATED SEPTEMBER 21, 1976

ADDENDUMS I AND II

Cessna Aircraft Company
Pawnee Division
Wichita, Kansas

AD 199

INDEX

INTRODUCTION

This report defines the contractor task on the Design of a Ride Comfort System on a Cessna 172K Aircraft. These tasks are as follows:

A. SYSTEM DESIGN

B. DRAWINGS

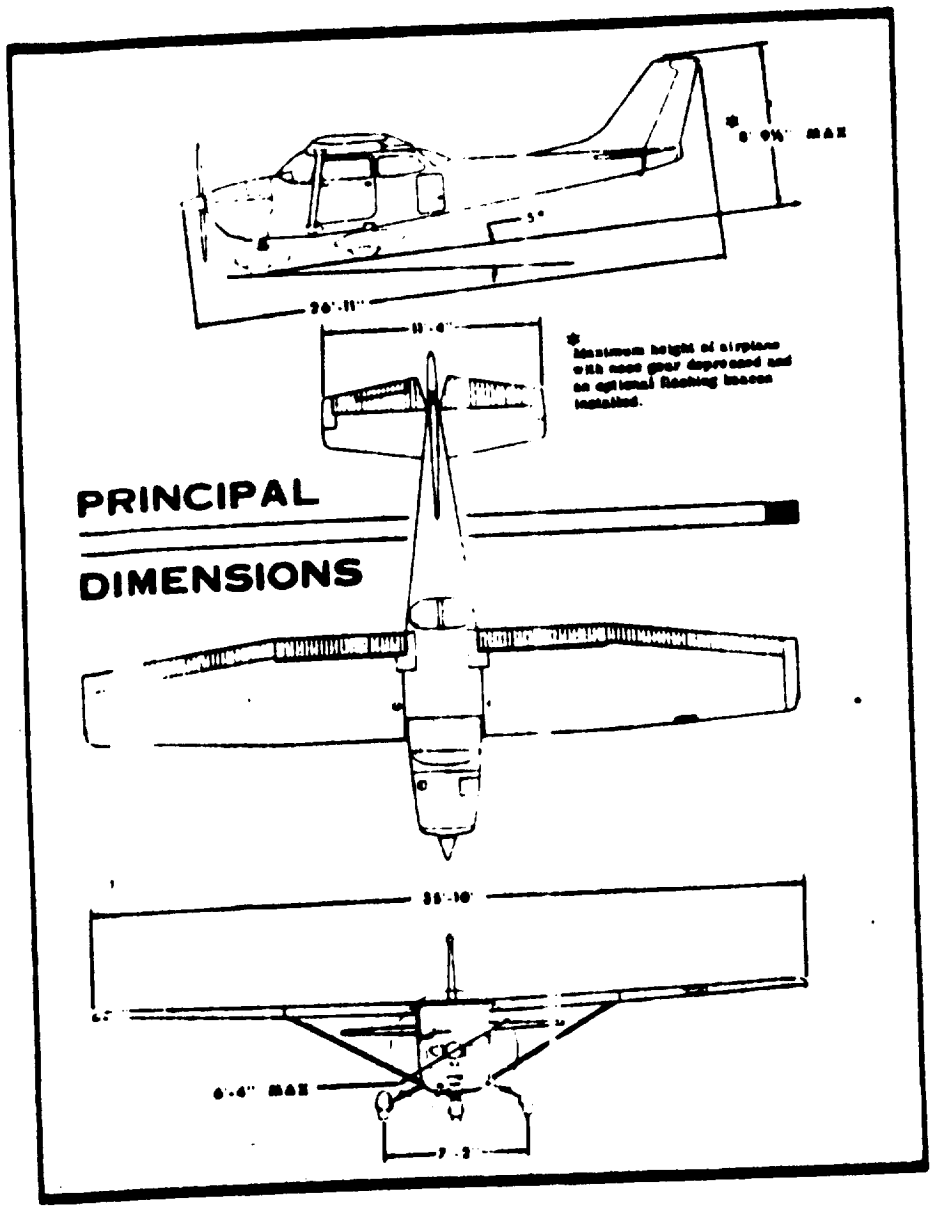
C. DESIGN LOADS & STRESS ANALYSIS

D. WEIGHT & BALANCE AND INERTIA ANALYSIS

E. FAILURE MODE & EFFECT ANALYSIS

F. BUDGETARY ESTIMATE

G. RECOMMENDATIONS

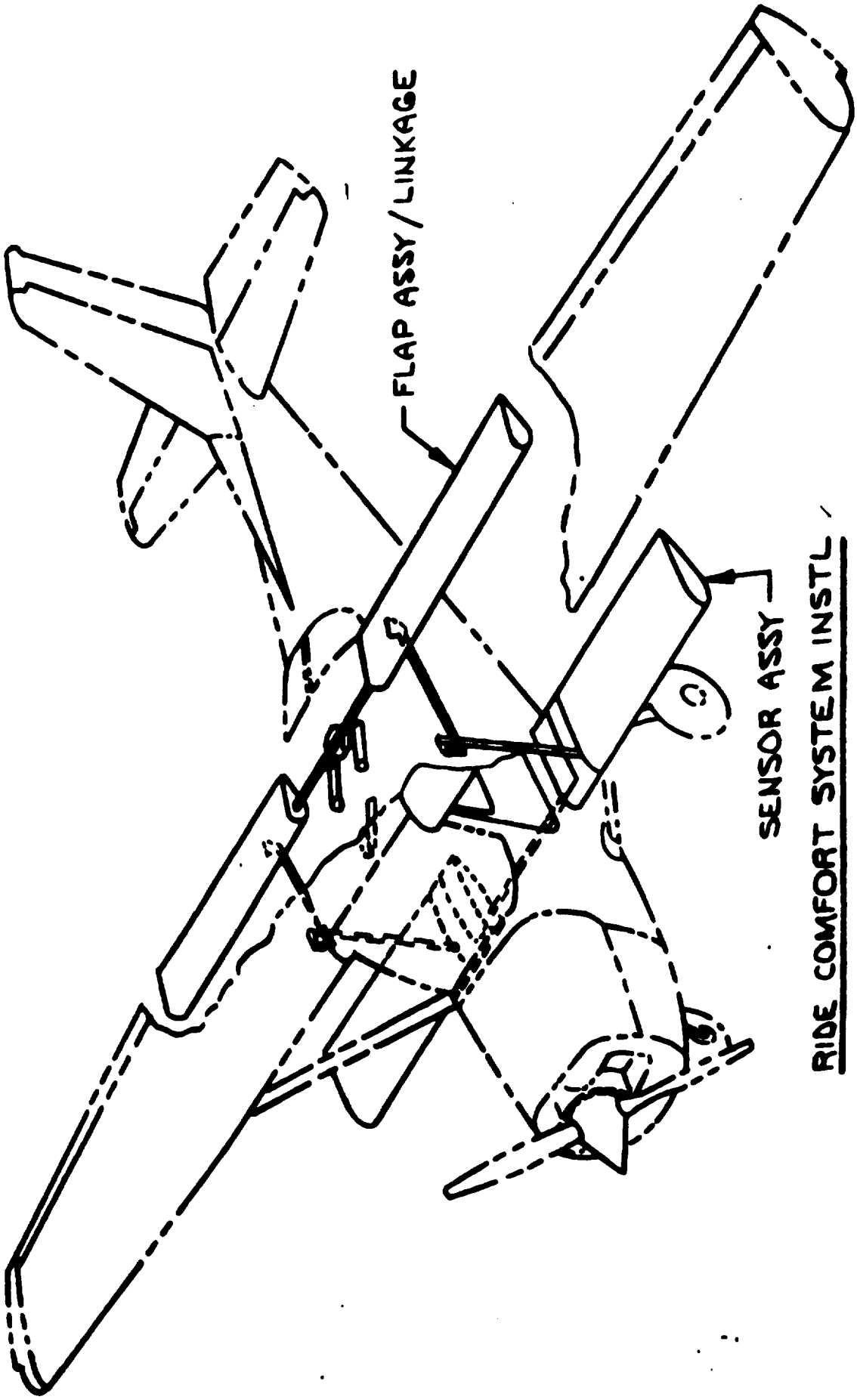

PRINCIPAL
DIMENSIONS
* Maximum height of airplane with nose gear depressed and an optional flashing beacon installed.
5°
35'-10"
6'-6" MAX

A. SYSTEM DESIGN

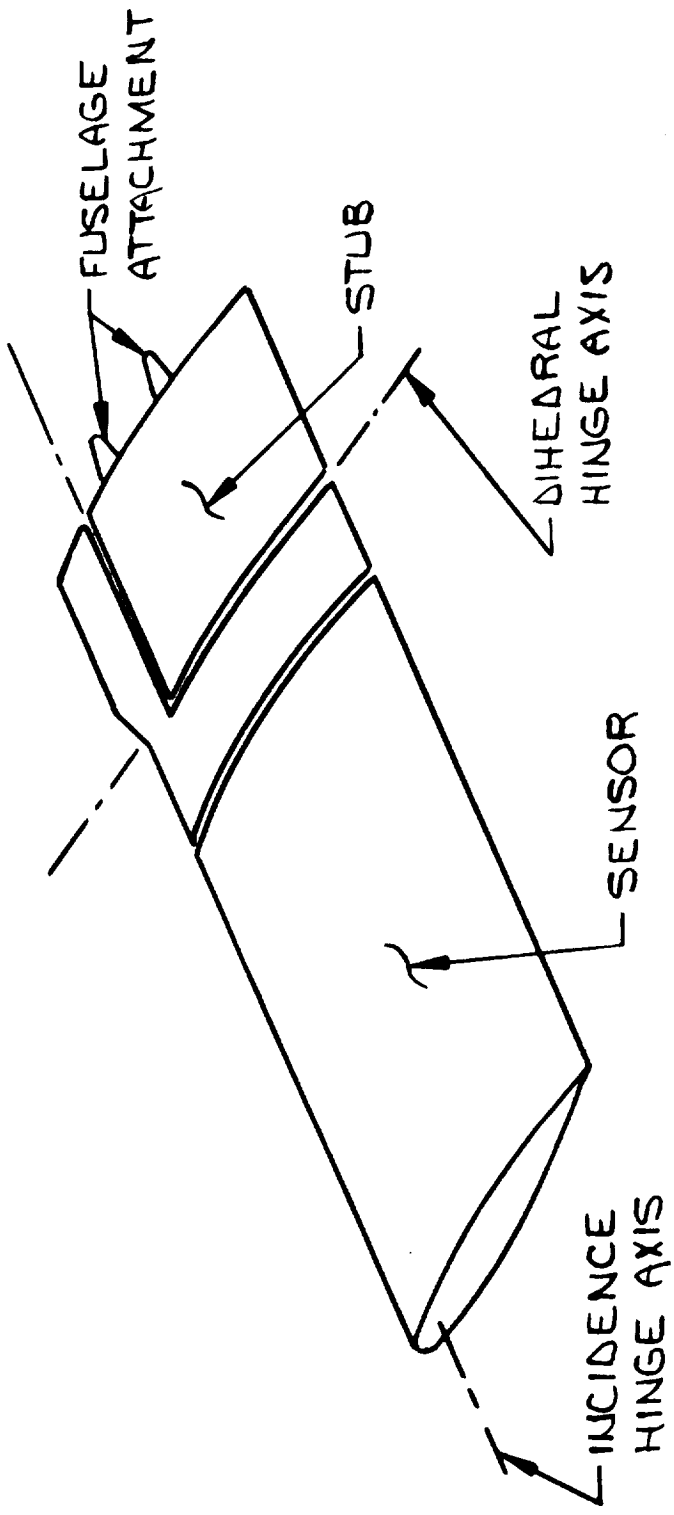
The system was designed to meet the requirements as defined in NASA's Statement of Work 1-12-5563 dated April 7, 1975 and Addendum I and Addendum II.

The following pages, 4 thru 23, provide conceptual drawings on the basic design of the system. Drawings in Item B of this report define the detail design. The system design pertains to the following items:

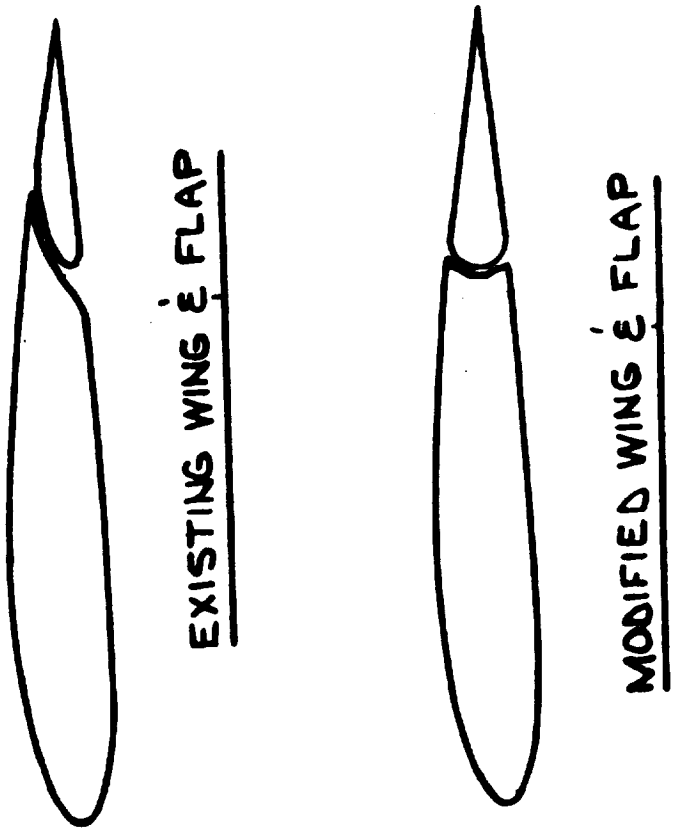
1. SENSOR - FLAP INTERCONNECT
2. SENSOR ROTATION - INCIDENCE
3. COCKPIT CONTROL/SENSOR INCIDENCE TRIM
4. VARIABLE LINK - SENSOR/ELEVATOR CONTROL - GROUND ADJUSTABLE
5. VARIABLE LINK LOCKOUT - PILOT ACTUATED DISCONNECT
6. SENSOR/FLAP TRIM SPRINGS
7. FLAP LOCKOUT AND TRAVEL LIMITS
8. COCKPIT FLAP ANGLE DISPLAY

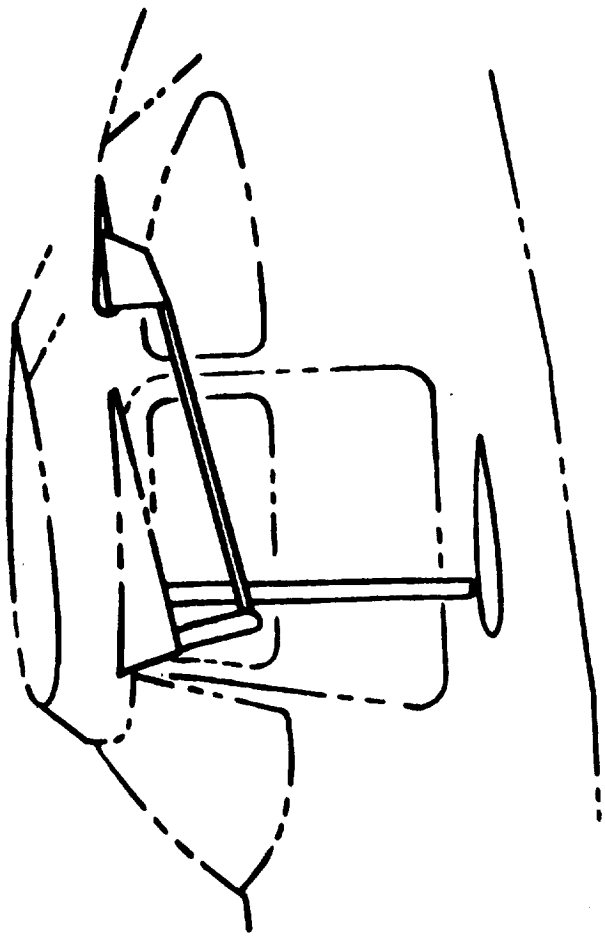


RIDE COMFORT SYSTEM INSTL


FUSELAGE ATTACHMENT
STUB
DIHEDRAL HINGE AXIS
SENSOR
INCIDENCE HINGE AXIS

SENSOR ASSY

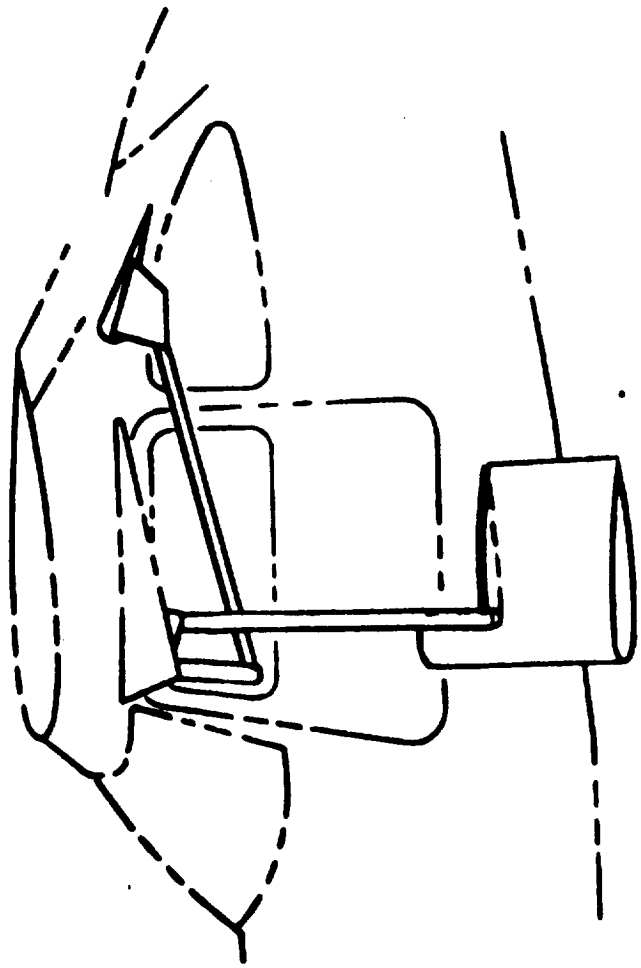

EXISTING WING & FLAP
MODIFIED WING & FLAP

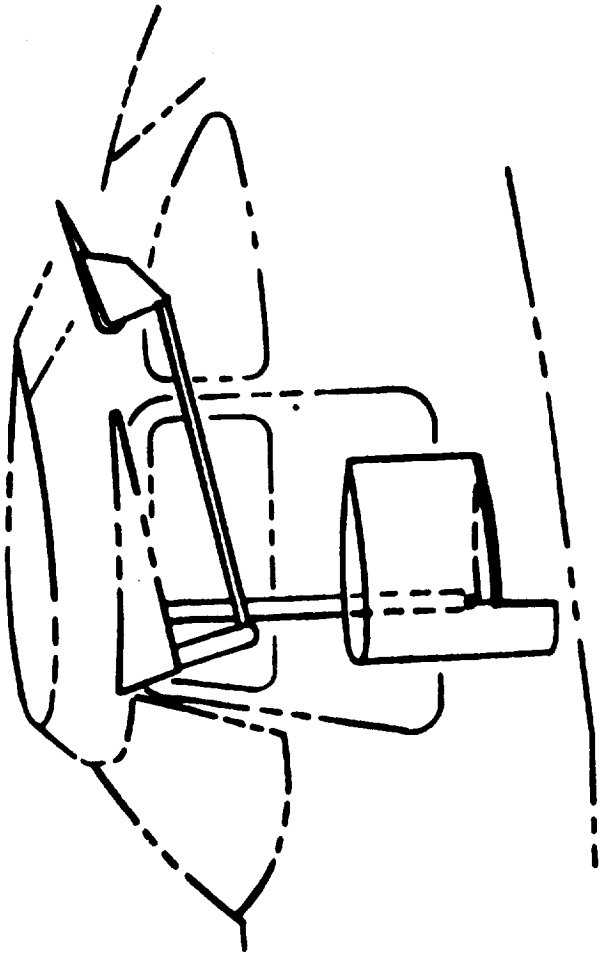


SENSOR - FLAP INTERCONNECT

SENSOR DIHEDRAL 0°

FLAP 0°

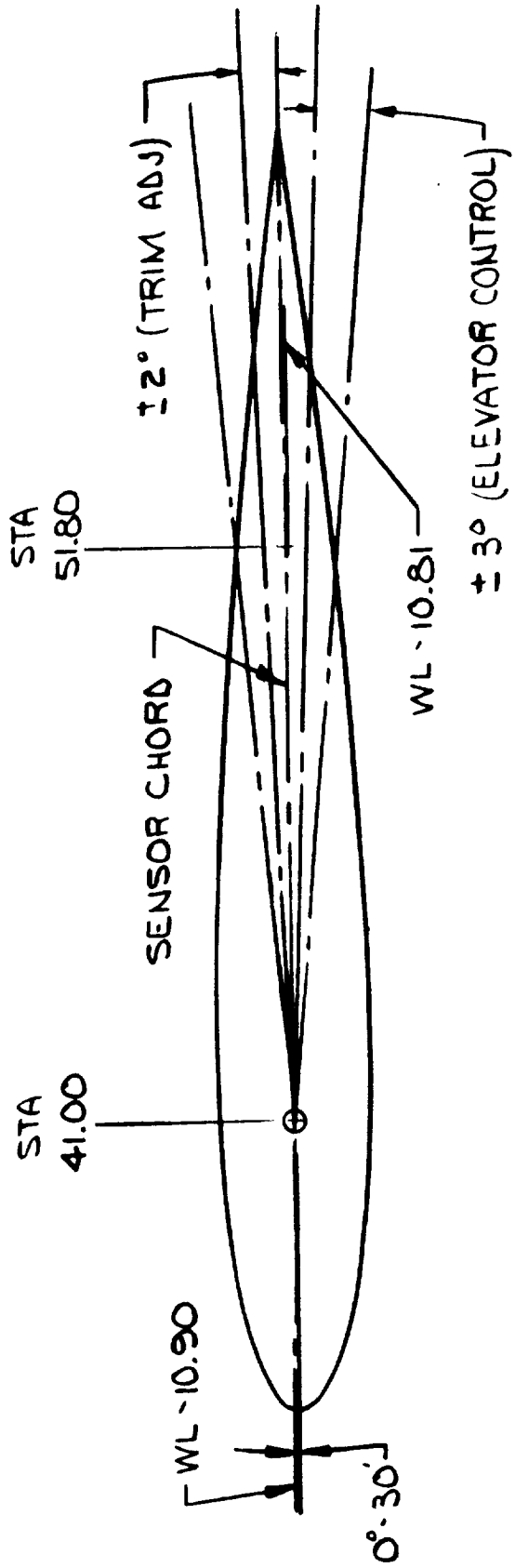

SENSOR - FLAP INTERCONNECT
SENSOR DIHEDRAL 20° DOWN
FLAP 20° DOWN



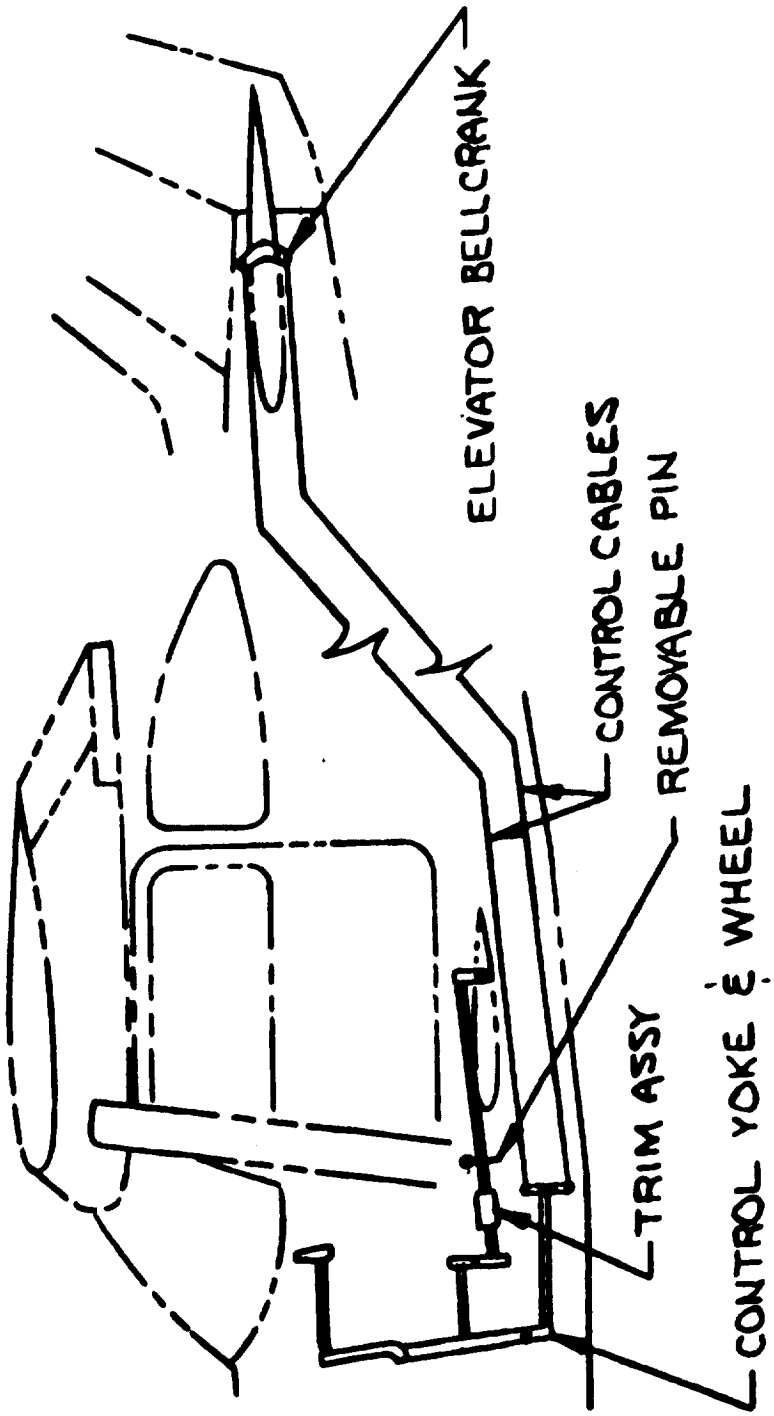
SENSOR - FLAP INTERCONNECT

SENSOR DIHEDRAL 20° UP

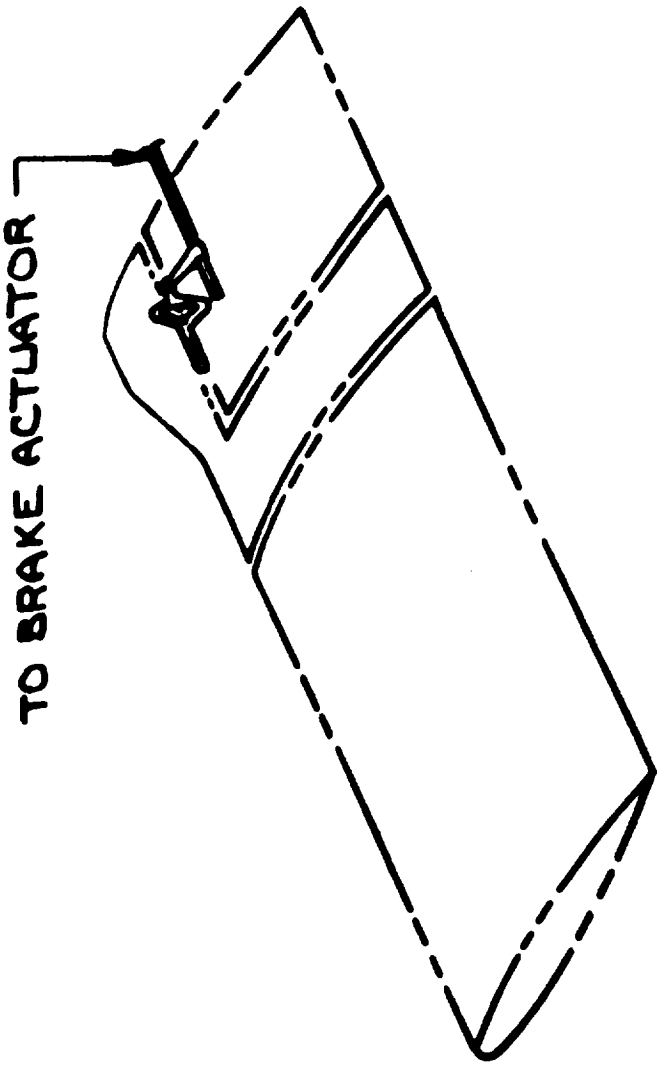
FLAP 20° UP



SENSOR INCIDENCE ANGLES

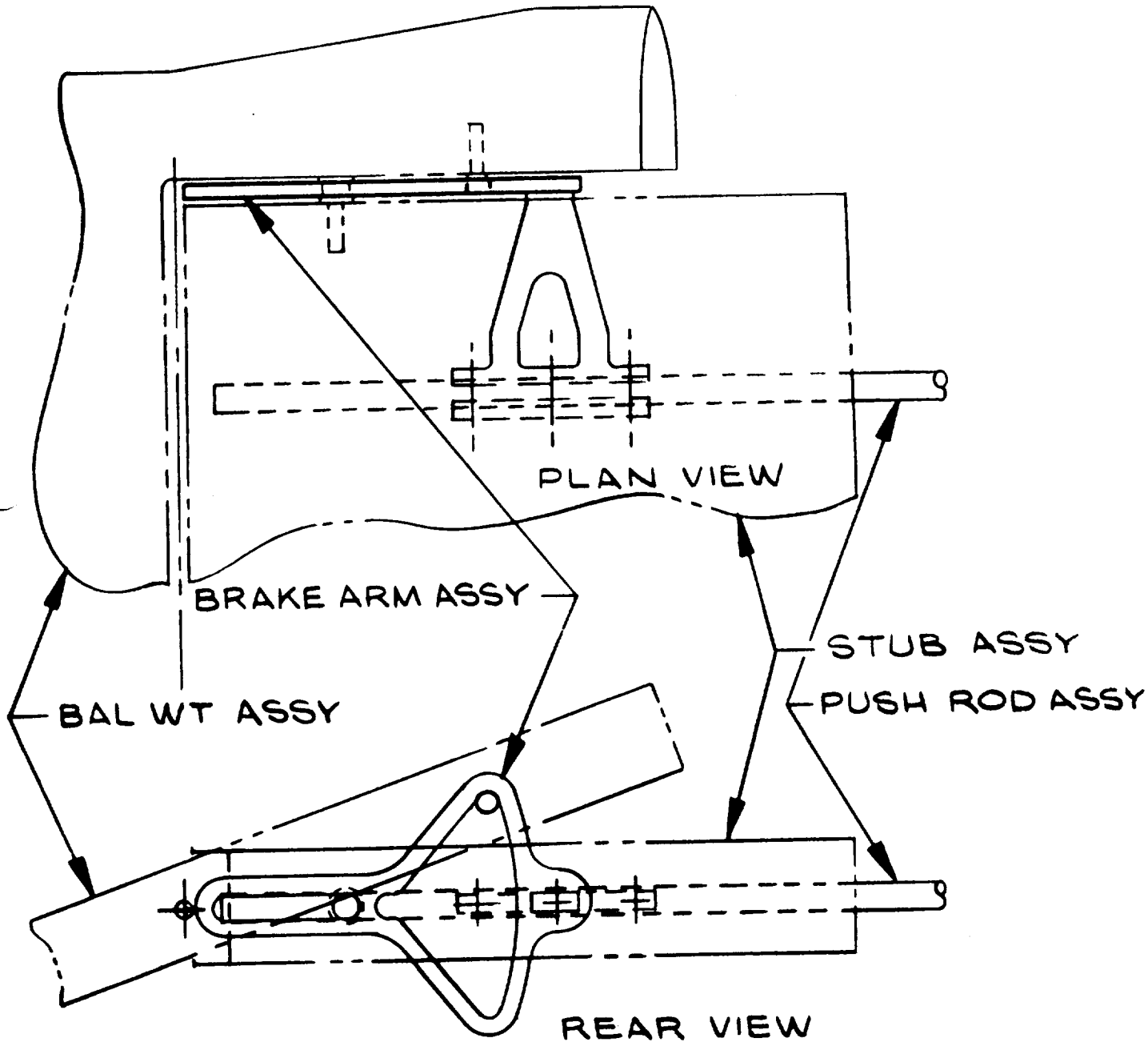


SENSOR - ELEVATOR INTERCONNECT

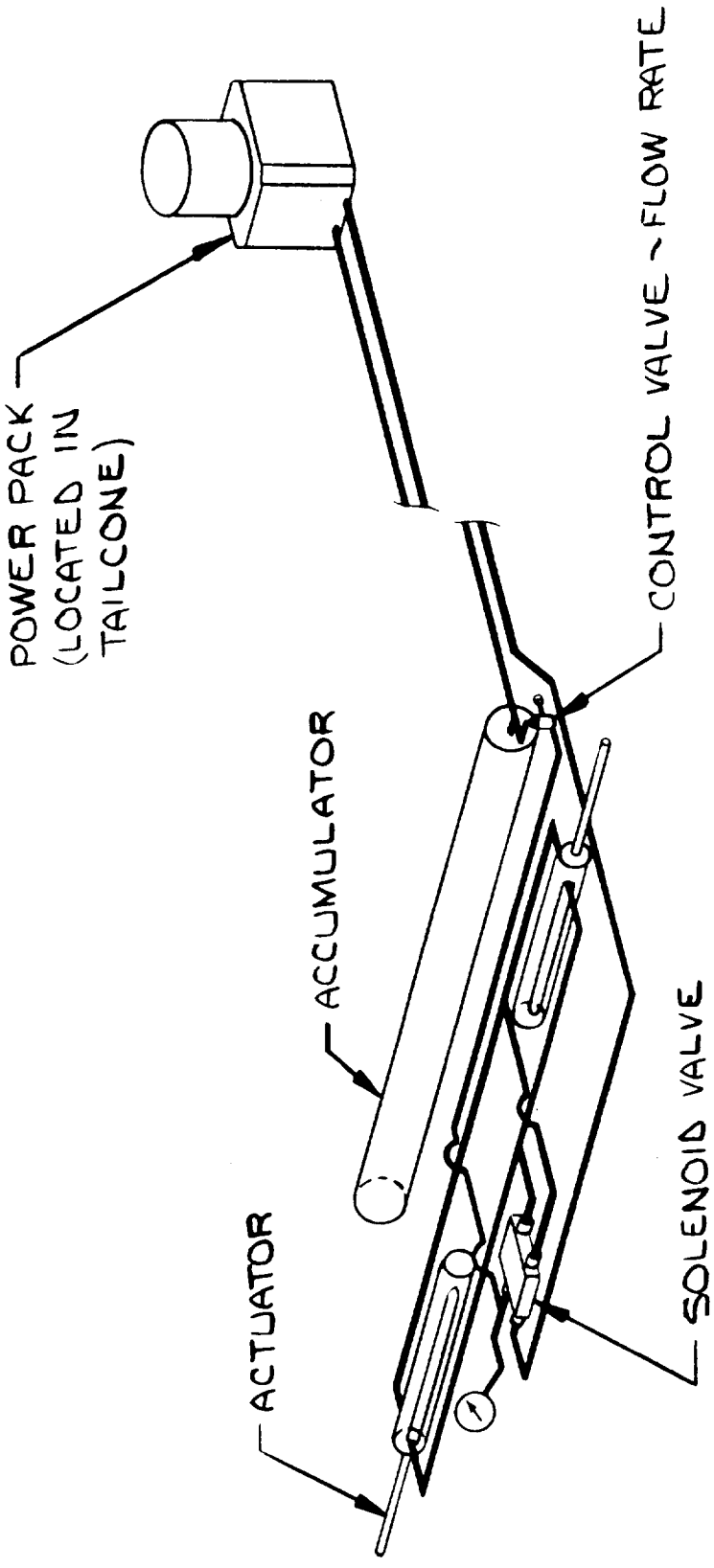


SENSOR DIHEDRAL BRAKE INSTL

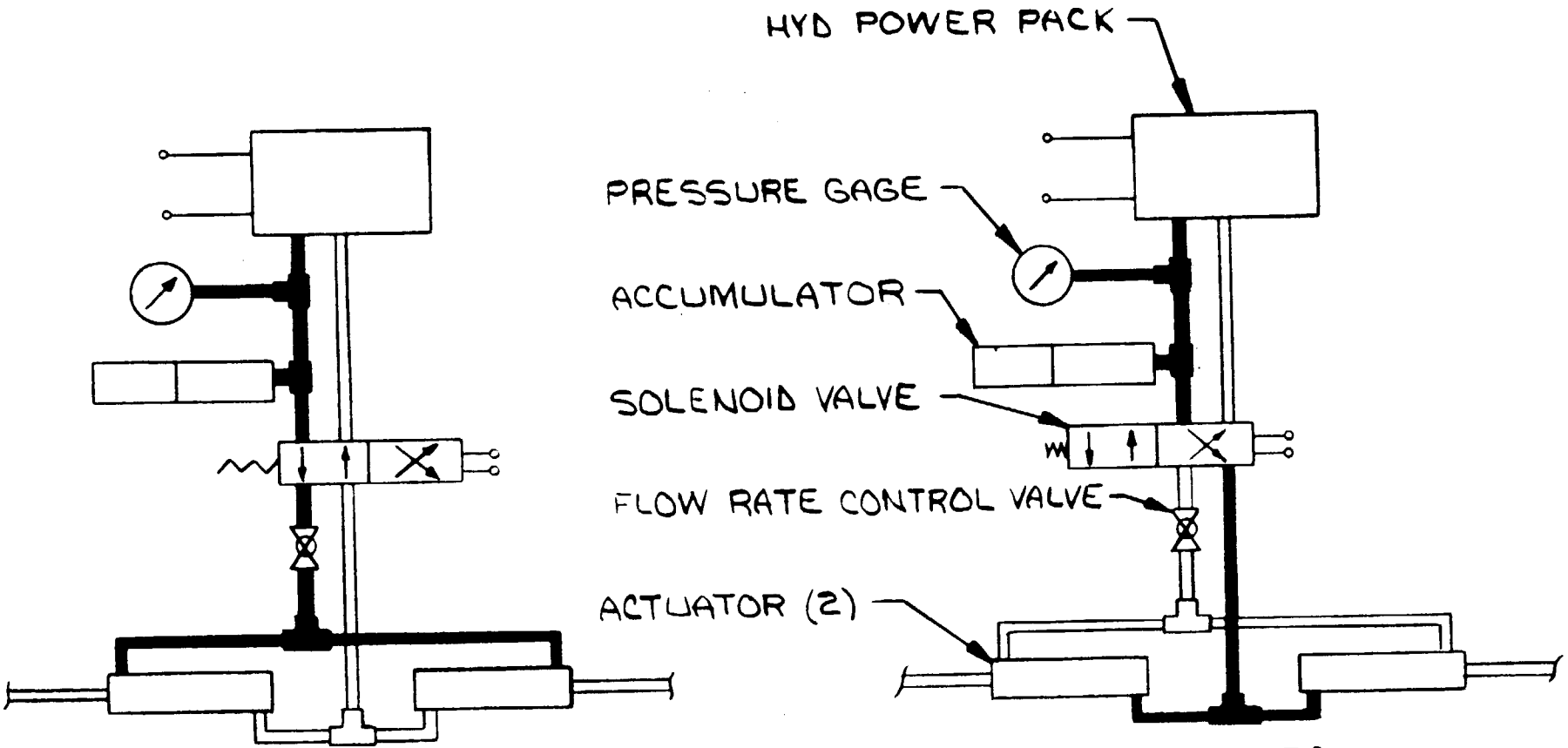
SENSOR DIHEDRAL BRAKE



BASIC BRAKE ARM INSTL (SENSOR)

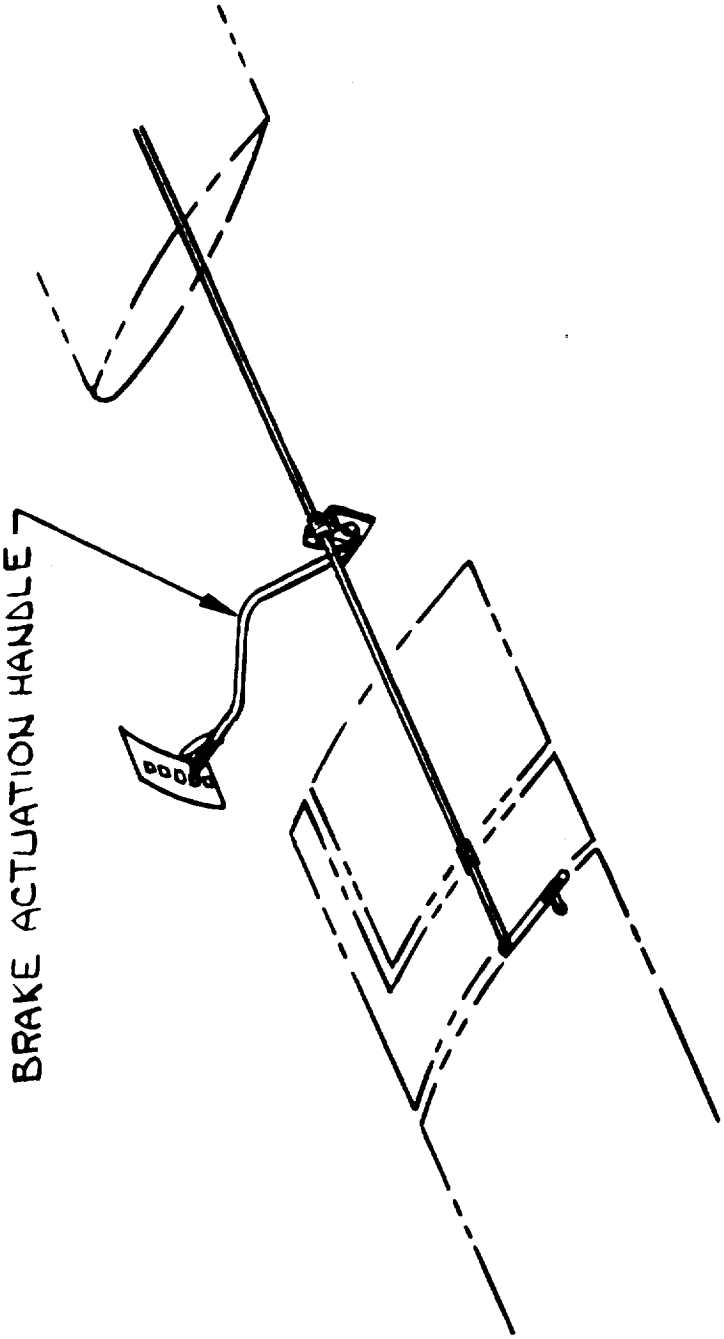


SENSOR DIHEDRAL BRAKE INSTL
CABIN FLOORBOARD AREA

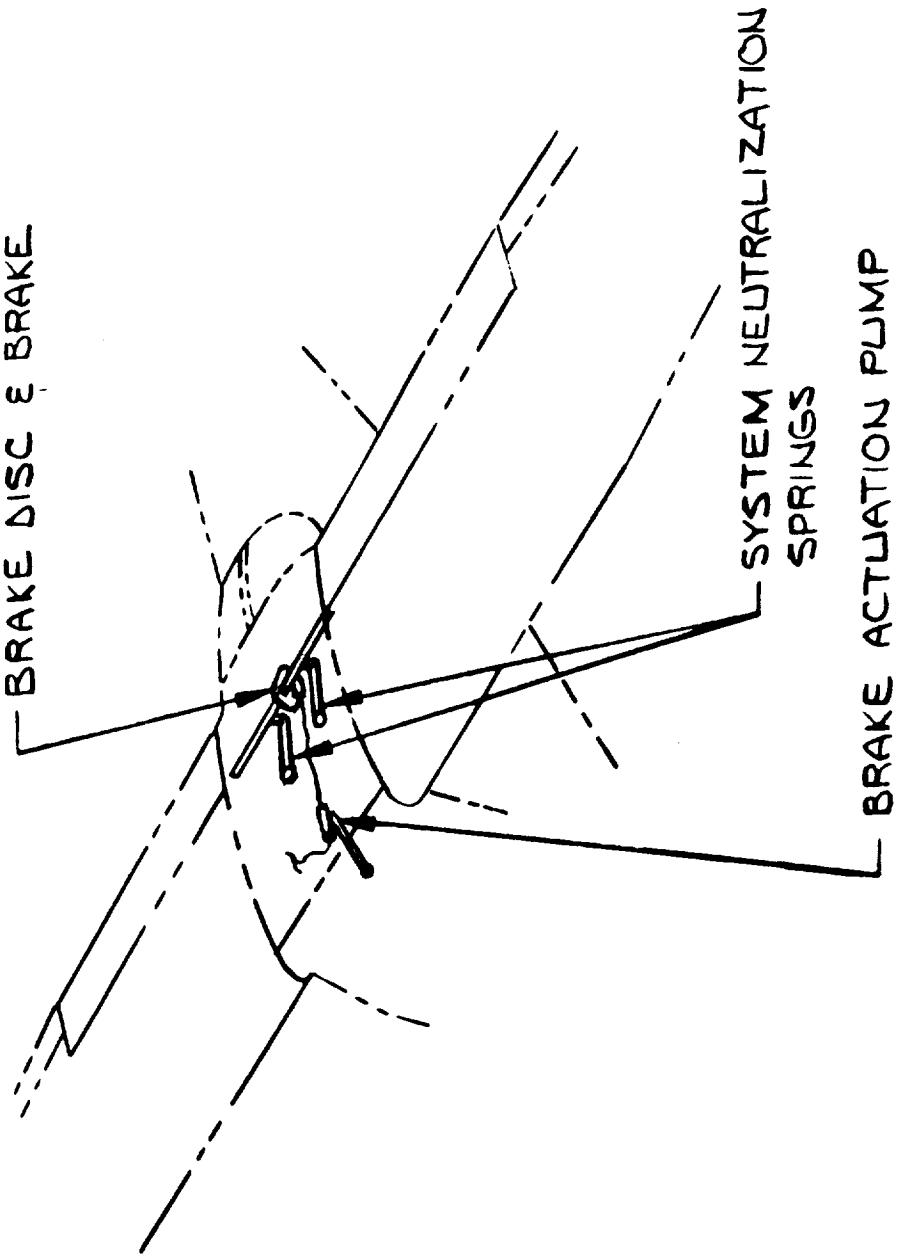


- POWER PACK KEEPS ACCUMULATOR CHARGED TO 1800 PSI
- ACTUATOR SPEED IS VARIED BY ADJUSTING FLOW RATE CONTROL VALVE
- SHOULD ELECTRICAL FAILURE OCCUR, SOLENOID WOULD AUTOMATICLY SWITCH TO LOCKING POSITION

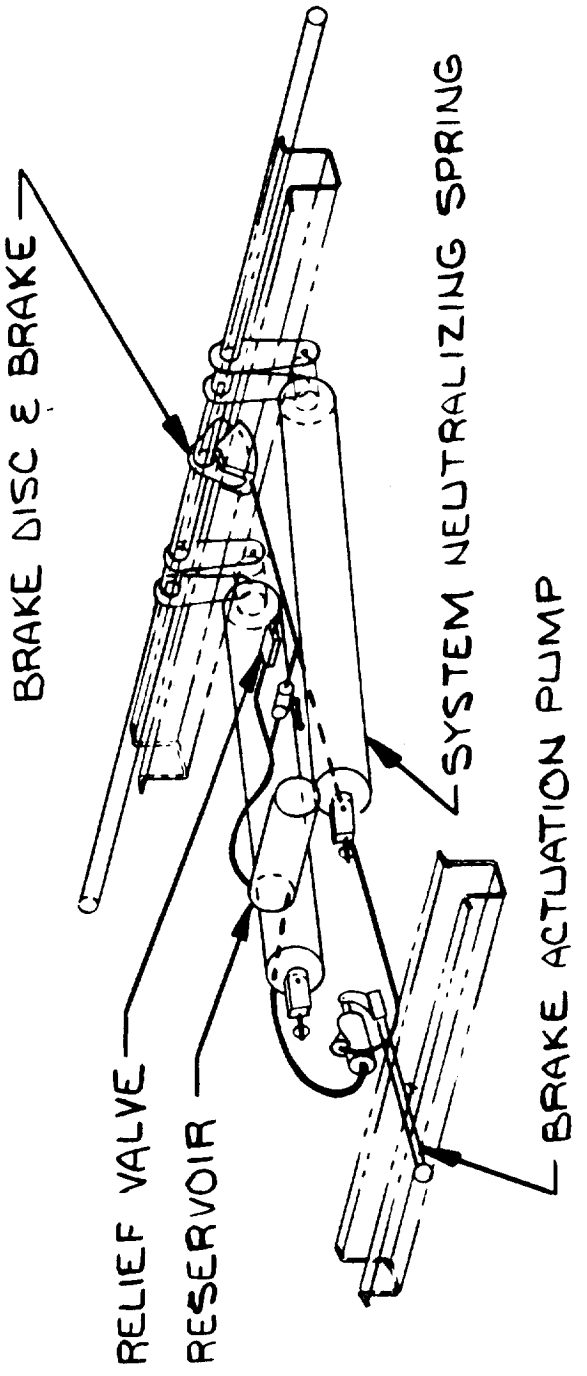
FLOW DIAGRAM ~ SENSOR BRAKE



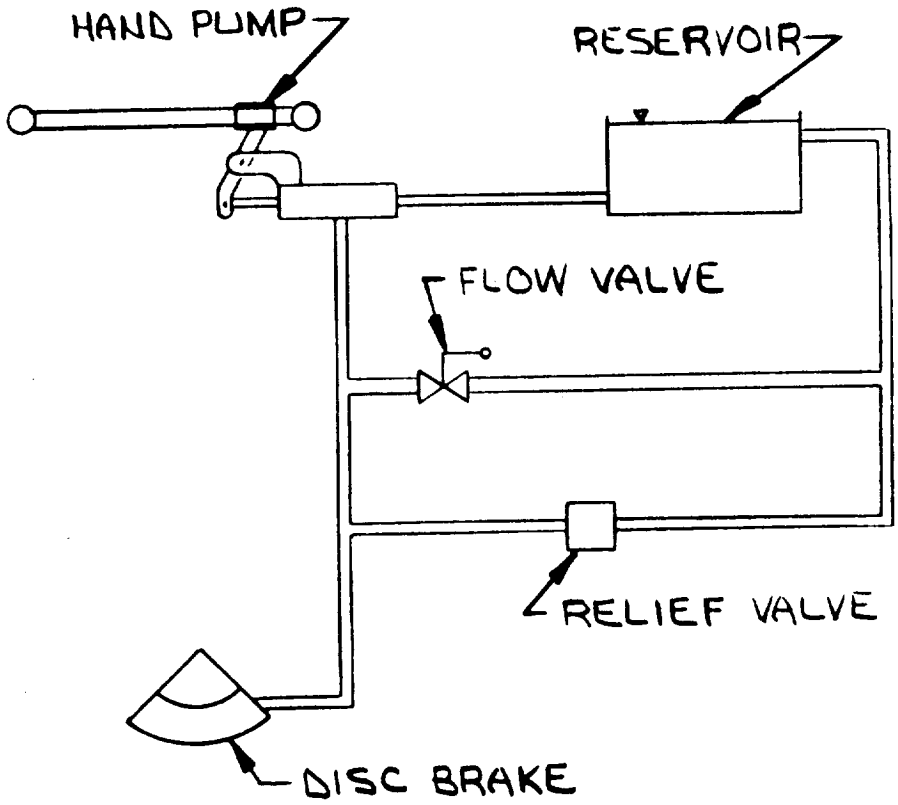
SENSOR INCIDENCE BRAKE INSTL



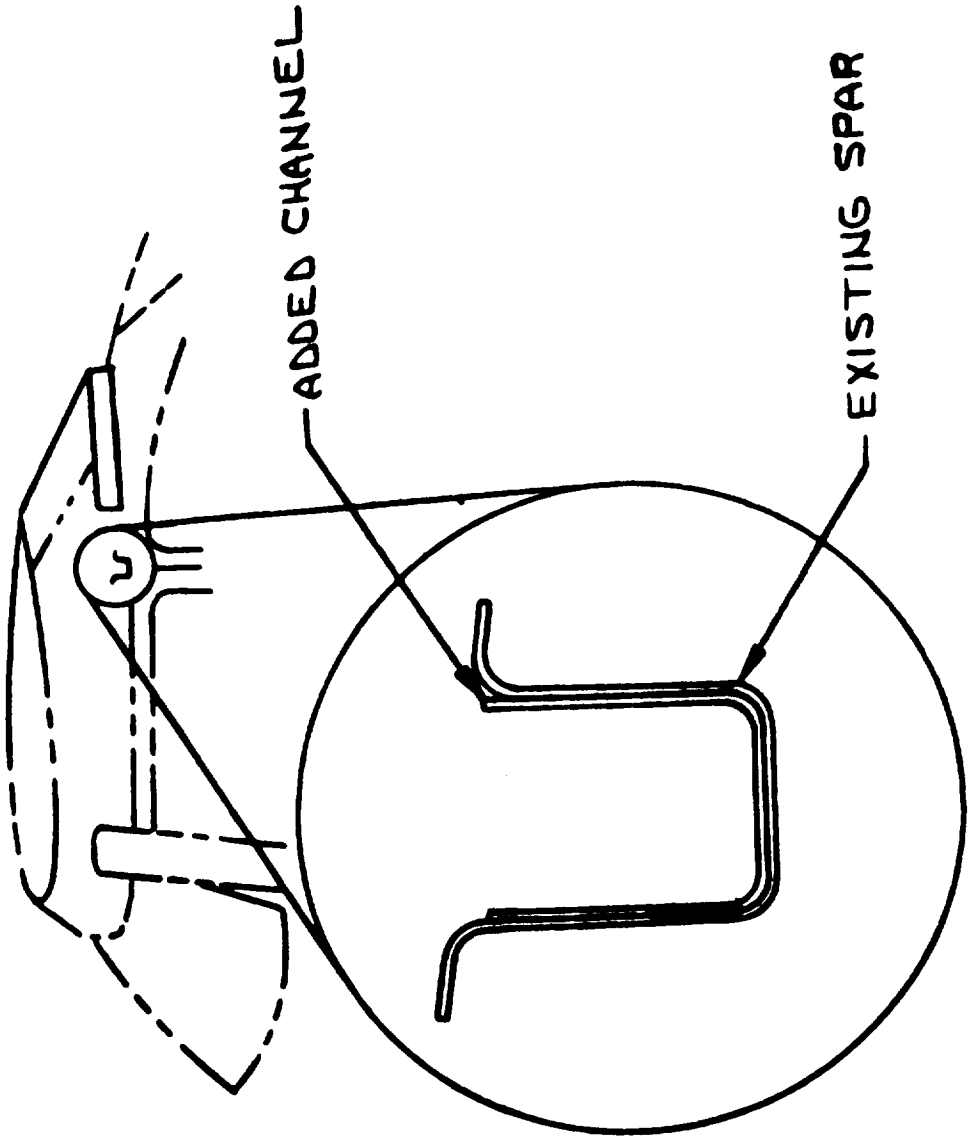
FLAP BRAKE INSTL



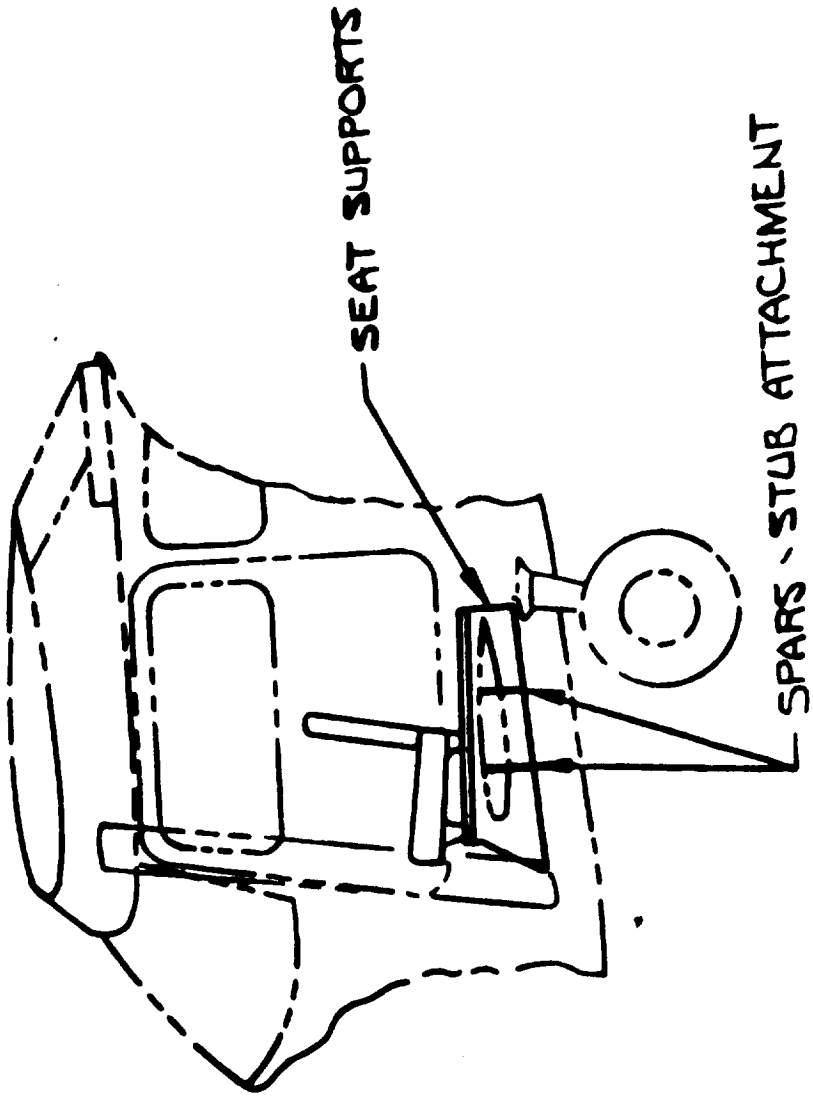
FLAP DISC BRAKE
CABIN TOP AREA



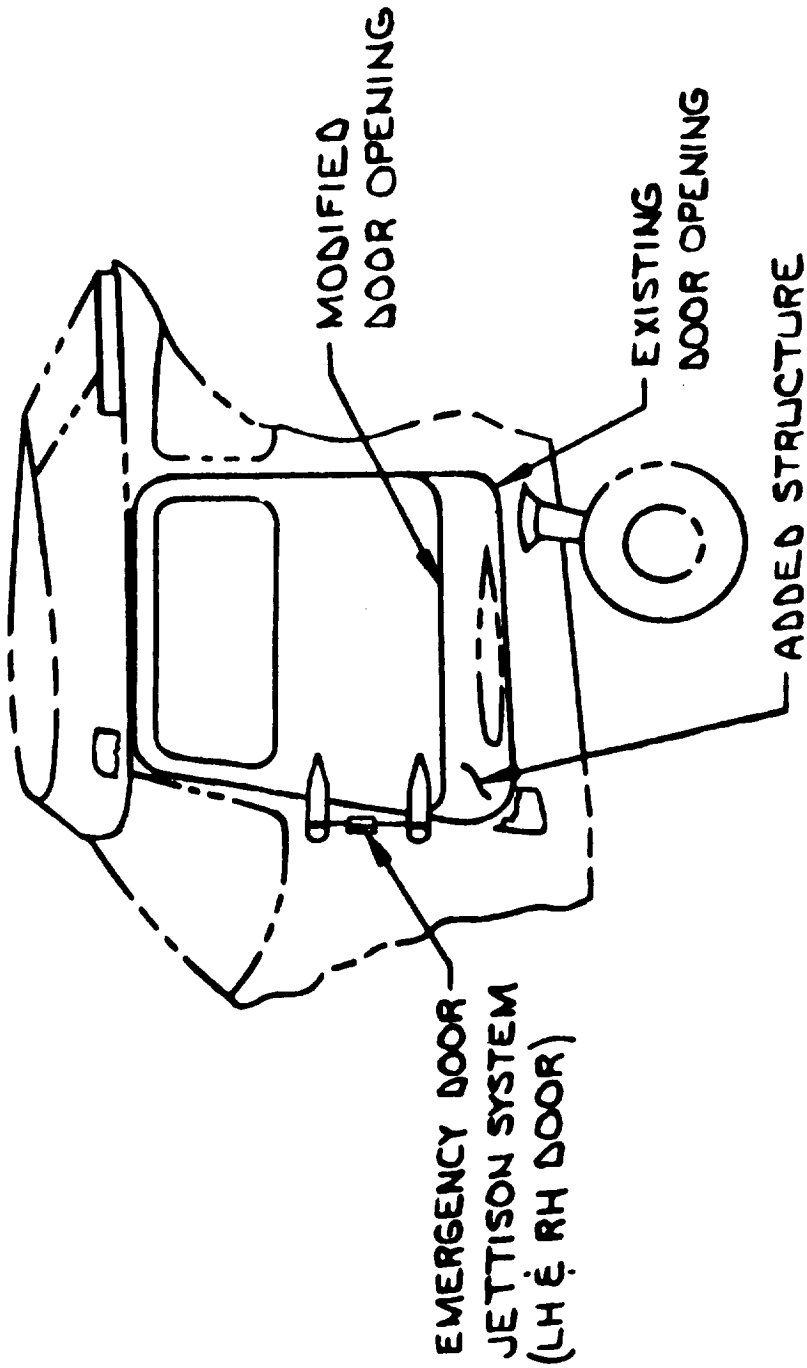
FLAP DISC BRAKE



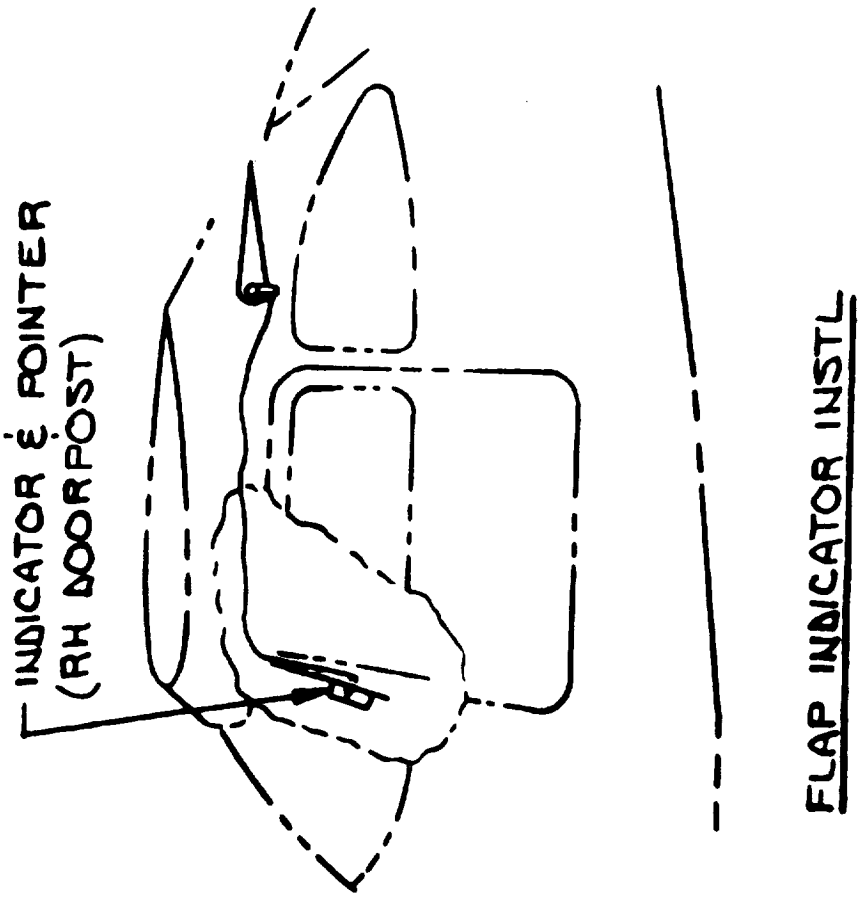
REAR SPAR MODIFICATION



SENSOR STUB ATTACH &
SEAT SUPPORT PROVISIONS



DOOR MODIFICATION



FLAP INDICATOR INSTL

B. DETAIL DRAWINGS

Cessna detail design layout drawings define the systems as specified in NASA's Statement of Work 1-12-5563. The drawing list is as follows:

CESSNA NO.	TITLE
12172-650	Gust Alleviation System Installation
12172-651	Fillet Assembly - Wing
12172-652	Flap Indicator System
12172-653	Stub Attachment
12172-654	Rib Assembly - Wing
12172-655	Rear Spar Assembly
12172-656	Aft Fuselage Spar Modification
12172-657	Flap Brake Installation
12172-659	Door Modifications
12172-660	Flap - Symmetric
12172-661	Bracket - Sensor Incidence Torque Tube Bearing Support
12172-662	Lug Assembly - Sensor Push Rod Attach
12172-663	Rib - Sensor, Outboard
12172-664	Rib - Sensor
12172-665	Rib - Sensor, Inboard
12172-666	Spar - Sensor Carry-Thru
12172-667	Shaft - Sensor Dihedral Hinge
12162-668	Bearing Support Assembly - Sensor Incidence
12172-669	Spacer Assembly - Sensor Incidence
12172-670	Bearing Block Assembly - Sensor Incidence
12172-671	Housing Assembly - Bearing, Sensor Incidence
12172-672	Shaft Assembly - Sensor Pivot
12172-673	Forward Hinge Assembly - Sensor Dihedral
12172-674	Aft Hinge Assembly - Sensor Dihedral
12172-676	Spar Assembly - Forward, Balance Weight
12172-677	Rib - Outboard, Balance Weight
12172-678	Spar - Aft, Balance Weight
12172-679	Rib - Inboard, Balance Weight
12172-680	Spar - Forward, Stub
12172-681	Rib - Outboard, Stub
12172-682	Rib - Aft, Stub

CESSNA NO.	TITLE
12172-683	Rib - Center, Stub
12172-684	Spar Assemblies - Stub
12172-685	Sensor - Flap Interconnect Installation
12172-686	Sensor Assembly
12172-688	Spring Assembly - Sensor (70 & 85 Ft.Lbs.)
12172-689	Spring Assembly - Sensor (100 Ft.Lbs.)
12172-690	Spring Assembly - Sensor (125 & 150 Ft.Lbs.)
12172-691	Spring - Compression
12172-692	Clamp Half - Elevator Gain Push Rod
12172-693	Push Rod Assembly - Elevator Gain
12172-694	Bellcrank Assembly - Elevator Gain
12172-695	Incidence Control Installation - Sensor
12172-696	Bracket Assembly - Gain Control Bellcrank
12172-697	Sensor Trim Control
12172-698	Fuel Selector Valve Shaft Installation
12172-700	Brake Installation - Sensor
12172-701	Spacer - Balance Weight Bearing Housings
12172-702	Roller Assembly - Sensor Brake
12172-703	Arm Assembly - Dihedral Brake, Sensor
12172-704	Actuator Channel Installation
12172-705	Rib Assembly - Sensor Stub
12172-706	Disc Brake Assembly
12172-707	Brake Stop Assembly
12172-708	Bracket Assembly
12172-710	Bellcrank Assembly - Sensor Trim
12172-711	Placards
12172-712	Spring Adapter
12172-713	Bushing Assembly
12172-714	Rib - Sensor Inboard
12172-715	Piston Sensor Brake
12172-716	Fitting - Pressure Gauge

C. DESIGN LOADS AND STRESS ANALYSIS

Cessna Report S-000-224 provides the loads and stress analysis of the system as defined in NASA's Statement of Work 1-12-5563. The report is provided under separate cover.

D. WEIGHT AND BALANCE AND INERTIA ANALYSIS

Cessna Report S-000-224 provides the Weight and Balance and Inertia Analysis of the system in the static condition only as defined in NASA's Statement of Work 1-12-5563. This report is provided under separate cover.

E. FAILURE MODE AND EFFECT ANALYSIS

Cessna Report S-000-224 defines the Failure Mode and Effect Analysis on a 172K with the Ride Comfort System installed as defined by NASA's STATEMENT OF WORK 1-12-5563. This report is provided under separate cover.

F. BUDGETARY ESTIMATE

A budgetary estimate is provided by separate letter. The estimate is based on the following Statement of Work which defines the fabrication and installation of the Ride Comfort System installed on NASA's 172K aircraft.

STATEMENT OF WORK

SCOPE

This Statement of Work defines the program on the fabrication and installation of a Ride Comfort System on a Cessna 172K aircraft, as described on NASA Contact NASI-14013.

I. SERVICES, MATERIALS, FACILITIES

A. RECEIVE AIRCRAFT

Aircraft 17258729 is to be delivered to Cessna Pawnee Division Delivery Center at Wichita, Kansas by NASA. The aircraft is to be picked up by Cessna Engineering with acceptance flight by Flight Test, noting general condition and operation, and taken to Experimental for modification. Experimental Quality Assurance to record aircraft equipment and condition thereof, and various aircraft documents.

B. AIRCRAFT MODIFICATION

Cessna shall modify aircraft, as required, for installation of ride comfort system defined by NASA Contract NASI-14013. The

ride comfort system installation must comply with good commercial practices using FAA requirements as guidelines.

C. MANUFACTURED PARTS

Fabricated parts shall comply with CAR 3, Standard Commercial Aircraft Practices and Cessna Specifications. All fabricated parts shall be checked for conformity to comply with CAR 3, Standard Aircraft Practices and Cessna Specifications. Parts shall be inspected for conformity prior to and after installation. All parts requiring modification as a result of modifications which have occurred on NASA aircraft, serial 17258729, shall be done on Cessna Aircraft Form FM #1120 Disposition Tag. Quantity of parts fabricated shall be for Flight Test Article.

D. NEW PARTS

The existing wings on the NASA aircraft shall be removed and replaced with new Cessna manufactured wings modified per Cessna engineering drawings on previous contract describing the ride comfort system. NASA shall advise on disposition of removed wings.

E. CONTROL SYSTEM MODIFICATION

The control system is to be modified as described by Cessna engineering drawings on the ride comfort system. The modification shall not alter the primary control system. The control system modification will comply with CAR 3, Standard Aircraft Practices and Cessna Specifications.

F. STATIC PROOF TEST

Static proof tests shall be conducted on subject aircraft to design limit loads as described by Cessna Test Proposals. Tests shall be witnessed by NASA personnel. Static proof tests will be run with the ride comfort system in the locked position only. Tests to be conducted prior to NASA's return flight to Langley. Flutter analysis will be considered with system locked only.

G. FLIGHT TEST

Cessna shall conduct flight tests on subject aircraft with ride comfort system in the locked position to determine that the aircraft is airworthy for return ferry flight to Langley by NASA personnel.

H. DOCUMENTATION

Cessna shall provide NASA with checklists, parts sequence and system adjustments prior to NASA's acceptance of aircraft.

I. DELIVERY OF AIRCRAFT

The aircraft is to be picked up at Cessna Pawnee Division Delivery Center by NASA personnel. Aircraft to be fueled and ready for flyaway condition. Required repair and/or maintenance of any systems not associated with Ride Comfort System shall be negotiated with NASA.

II. RELIABILITY ENGINEERING

A. DESIGN SPECIFICATIONS

Per NASA Contract NASI-14013.

B. DESIGN REVIEW

Per NASA Contract NASI-14013.

C. FAILURE REPORTING SYSTEM

If failure of some item occurs during proof testing (Ref. Para. F), NASA personnel will witness disposition. In addition, a confirmation letter to NASA describing failure will be submitted.

D. FAILURE ANALYSIS AND CORRECTIVE ACTION

All parts requiring corrective action shall be described on Cessna Aircraft Form FM #1120 Disposition Tag which shall be forwarded to NASA.

III. QUALITY CONTROL

A. CHANGE CONTROL

Cessna engineering drawings shall be revised, as necessary, using standard Cessna engineering drawing drafting procedures.

B. FABRICATION CONTROL

All parts shall be checked to conformity in respect to CAR 3, Standard Aircraft Practices and Cessna Specifications.

C. ARTICLE AND MATERIAL CONTROL

Article and material control shall comply with CAR 3, Standard Aircraft Practices and Cessna Specifications.

D. PROCESS CONTROL

Process control shall be checked to conformity in respect to CAR 3, Standard Aircraft Practices and Cessna Specifications.

E. INSPECTION AND TESTS

Cessna Engineering shall prepare test proposals, test procedures, and test results. Each test specimen shall comply with these items.

F. INSPECTION AND TEST RECORDS

All documents regarding inspection and testing shall be recorded and identified in regard to tests and dates.

G. GOVERNMENT PROPERTY CONTROL

On receipt of aircraft, Quality Assurance will record items and operation condition as listed, (Ref. Para. I.A.).

H. CONFIGURATION CONTROL

Documents shall be maintained on aircraft in respect to items removed, added and modified.

IV. SCHEDULE

Twelve (12) months after receipt of contract.

V. ESTIMATE

The manhours shall be based on fabrication and installation of parts as described by Cessna engineering drawings on NASA Contract NASI-14013 which defines the Ride Comfort System on a Cessna 172K aircraft.

G. RECOMMENDATIONS

The contractor recommends that the ride comfort system be fabricated and installed on a Cessna Model 172K as stated in the Statement of Work (Ref. Section F of this report).

It is recommended that a complete flutter analysis be conducted before flight testing.

A comparison of performance, weight vs system performance should be evaluated before the system is manufactured and installed on a commercial aircraft since useful load is a very important part of the light airplane industry.